Overview

- Motivation
- MapReduce/Hadoop in a nutshell
- Experimental cluster hardware example
- Application areas at the Austrian National Library
  - Web Archiving
  - Austrian Books Online
- SCAPE at the Austrian National Library
  - Hardware set-up
  - Open source software architecture
- Application Scenarios

This work was partially supported by the SCAPE Project.
The SCAPE project is co-funded by the European Union under FP7 ICT-2009.4.1 (Grant Agreement number 270137).

Cultural Heritage and Big Data?

- Google Books Project
  - 2012: 20 million books scanned (approx. 7,000,000,000 pages)
  - www.books.google.com

- Europeana
  - 2012: 25 million digital objects
  - All metadata licensed CC-0
  - www.europeana.eu/portal

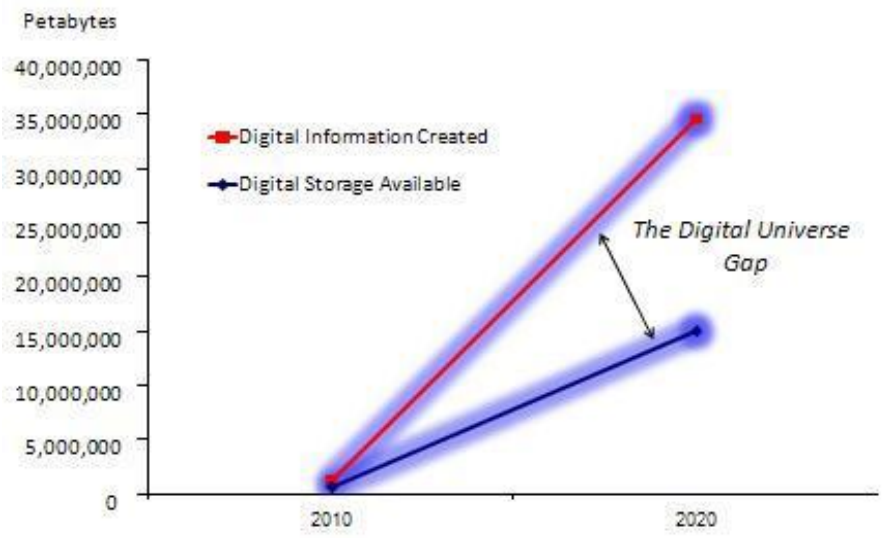
Cultural Heritage and Big Data?

- Hathi Trust
  - 3,721,702,950 scanned pages
  - 477 TBytes
  - www.hathitrust.org

- Internet Archive
  - 245 billion web pages archived
  - 10 PBytes
  - www.archive.org

What can we expect?

- Enumerate 2012: only about 4% digitised so far
- Strong growth of born digital information



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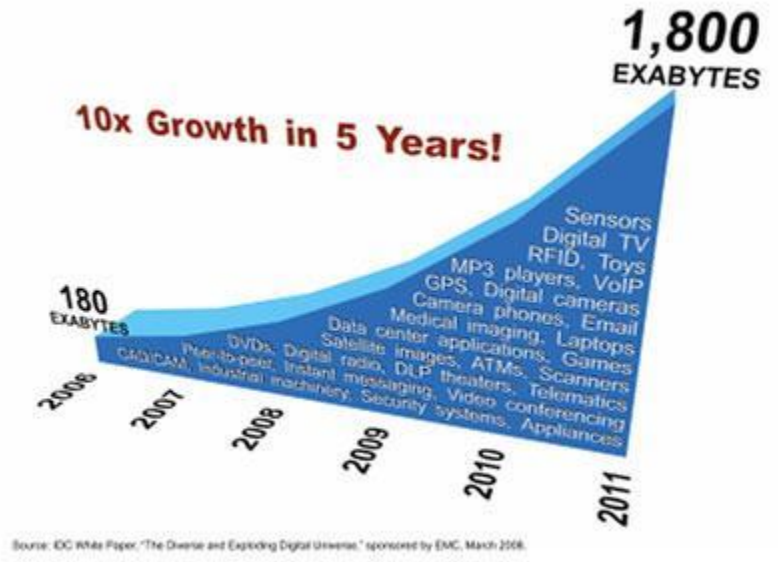
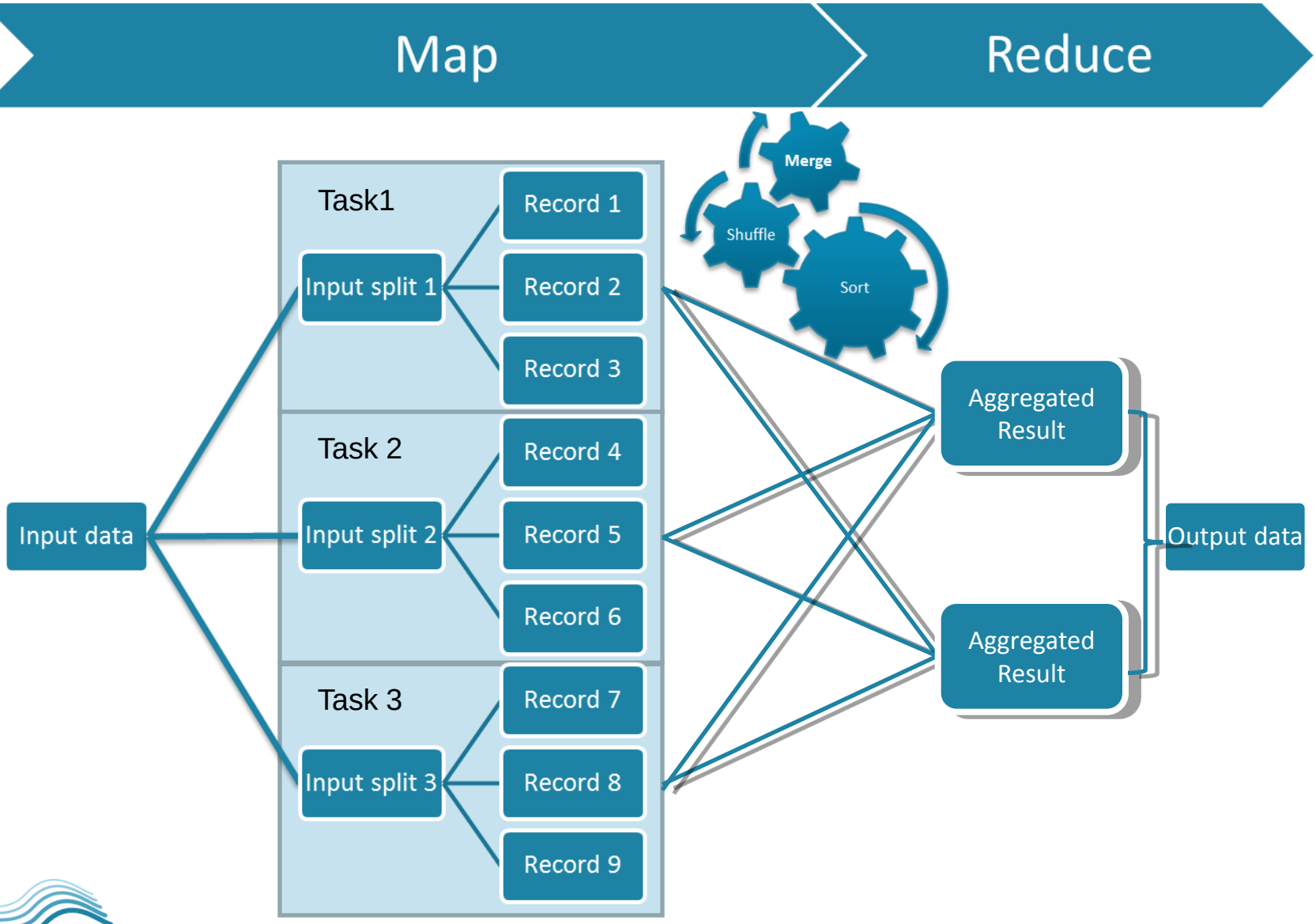


Source:

MapReduce/Hadoop in a nutshell



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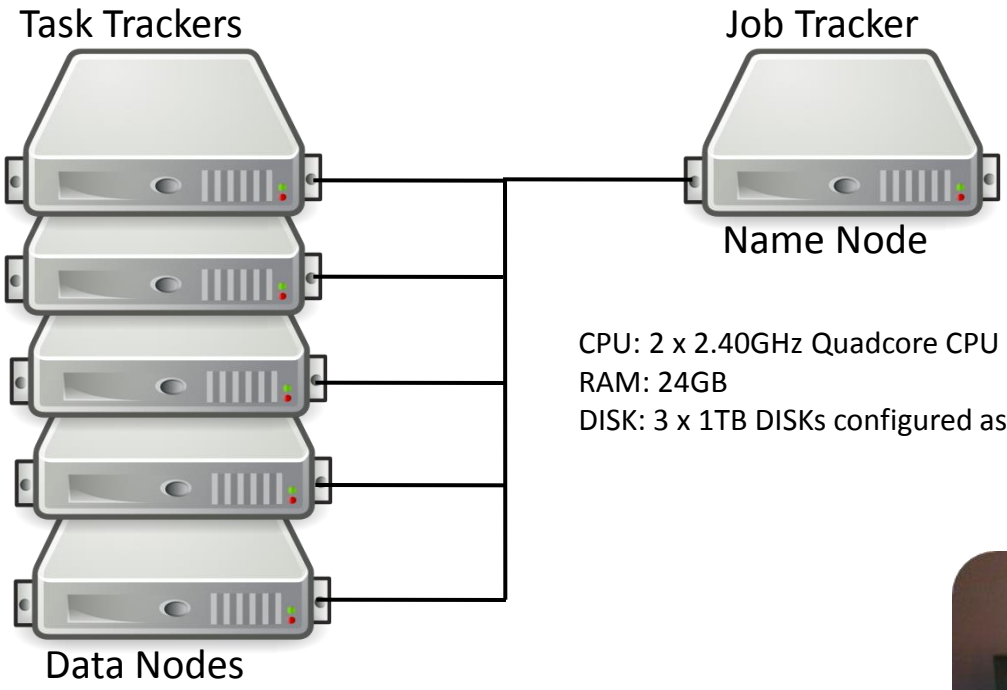
Experimental Cluster



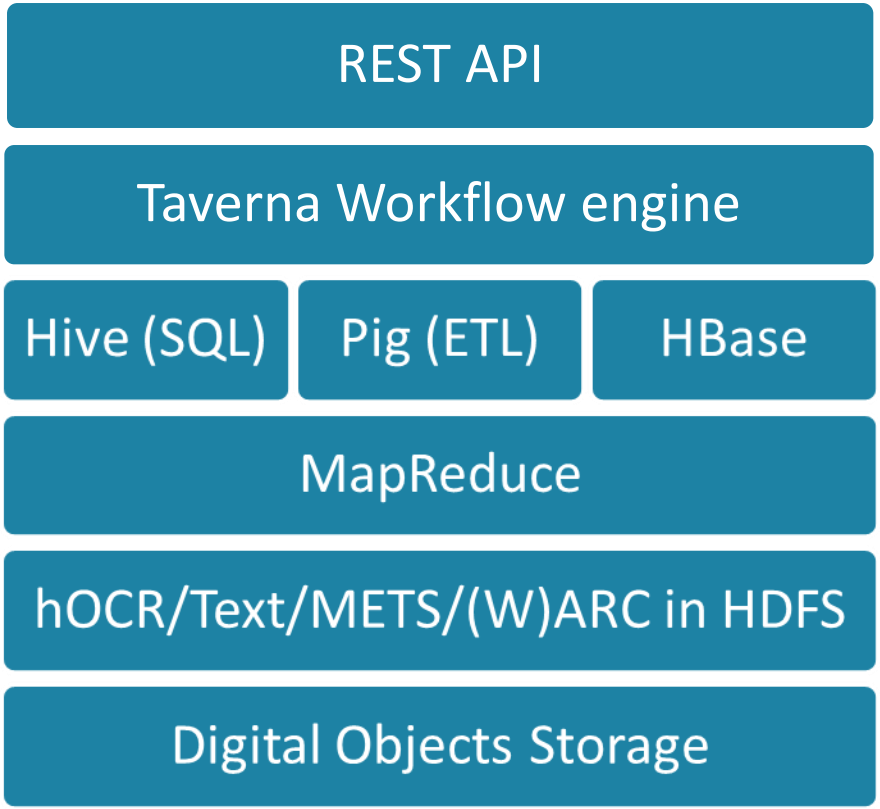
CPU: 2 x 2.40GHz Quadcore CPU (16 HyperThreading cores)
RAM: 24GB
DISK: 3 x 1TB DISKs configured as RAID5 (redundancy) – 2 TB effective

CPU: 1 x 2.53GHz Quadcore CPU (8 HyperThreading cores)
RAM: 16GB
DISK: 2 x 1TB DISKs configured as RAID0 (performance) – 2 TB effective

•Of 16 HT cores: 5 for Map; 2 for Reduce; 1 for operating system.

→ **25** processing cores for **Map** tasks and
→ **10** cores for **Reduce** tasks

Platform Architecture



- Access via REST API
- Workflow engine for complex jobs
- Hive as the frontend for analytic queries
- MapReduce/Pig for Extraction, Transform, and Load (ETL)
- „Small“ objects in HDFS or HBase
- „Large “ Digital objects stored on NetApp Filer

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Application scenarios

- Web Archiving
  - Scenario 1: Web Archive Mime Type Identification
- Austrian Books Online
  - Scenario 2: Image File Format Migration
  - Scenario 3: Comparison of Book Derivatives
  - Scenario 4: MapReduce in Digitised Book Quality Assurance

Key Data Web Archiving

Domain harvesting

Entire **top-level-domain .at** every 2 years

Selective harvesting

Important websites that change regularly

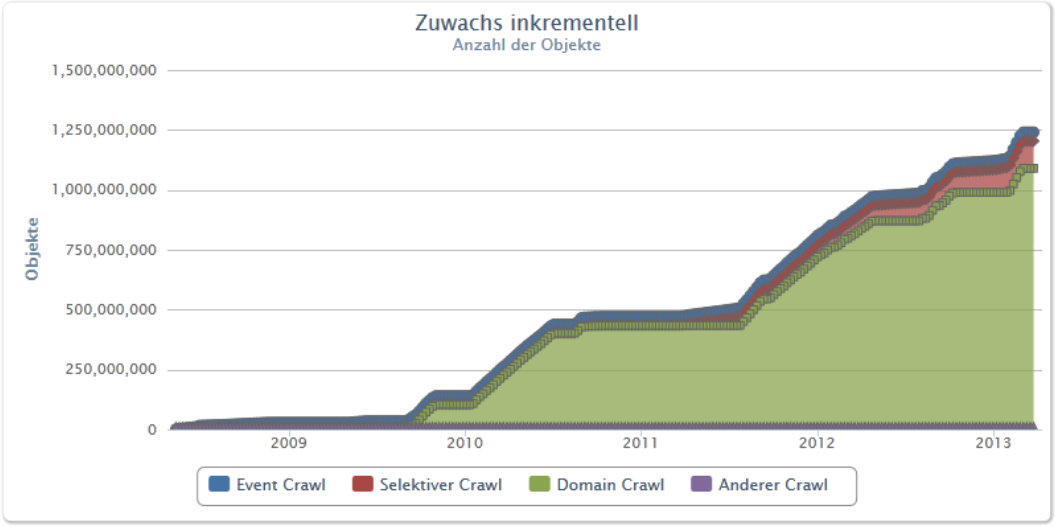
Event harvesting

Special occasions and events (e.g. elections)

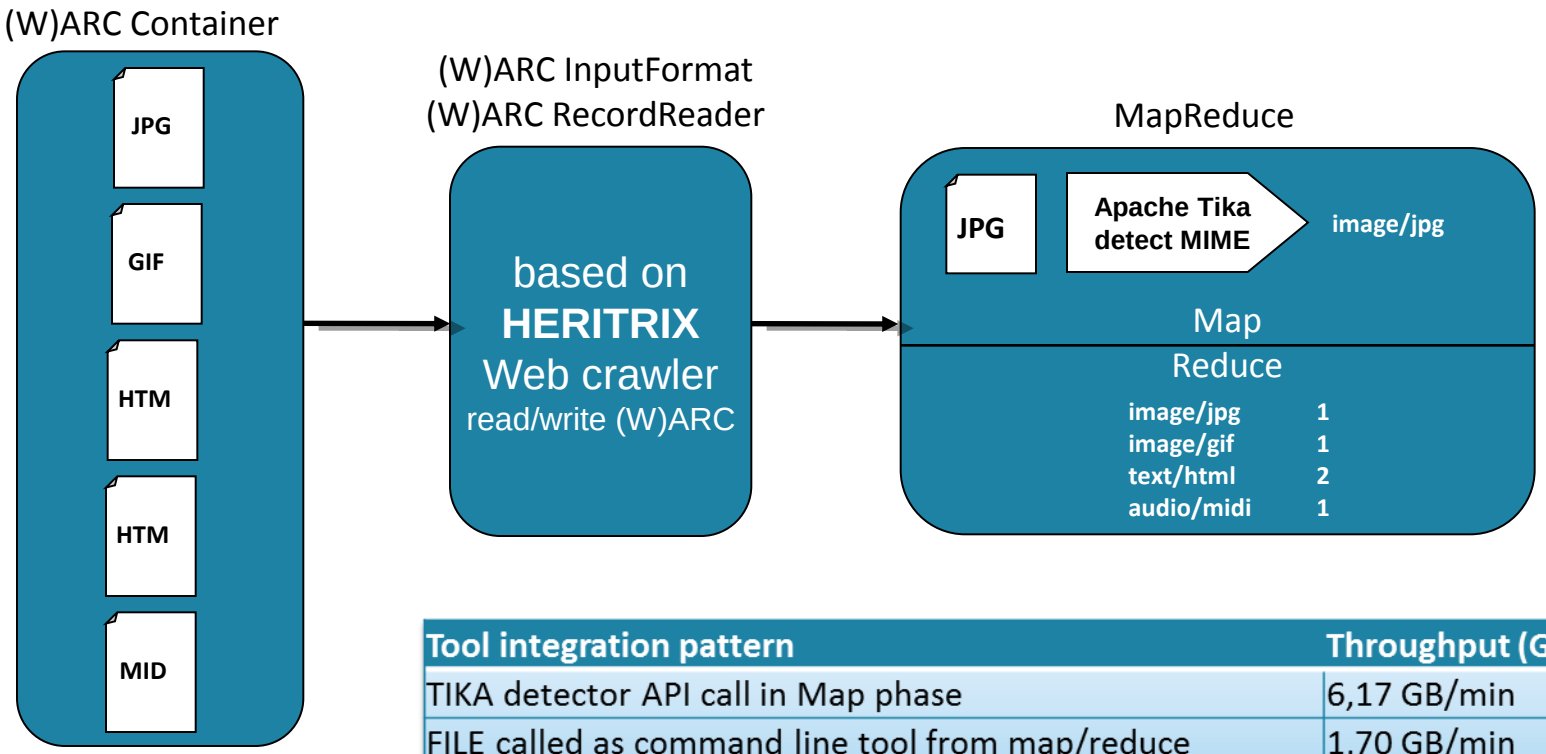
Physical storage 19 TB

Raw data 32 TB

Number of objects 1.241.650.566



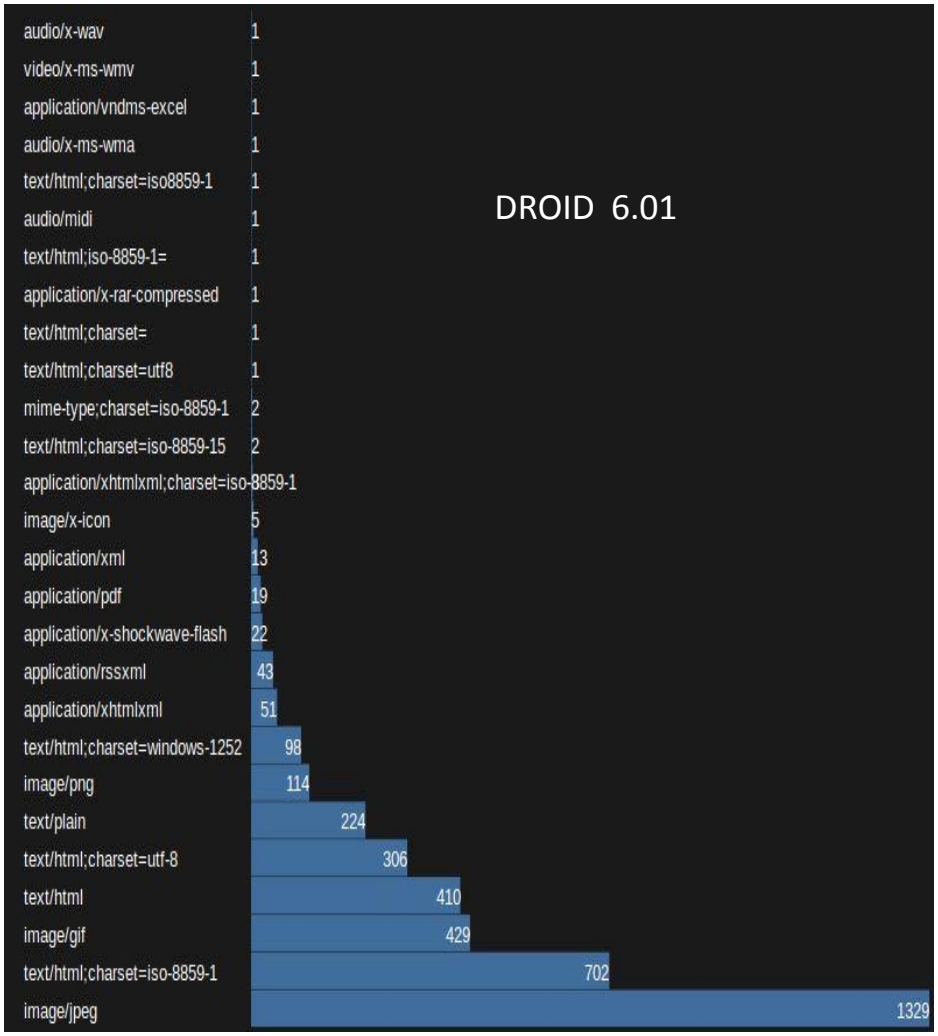
Scenario 1: Web Archive Mime Type Identification

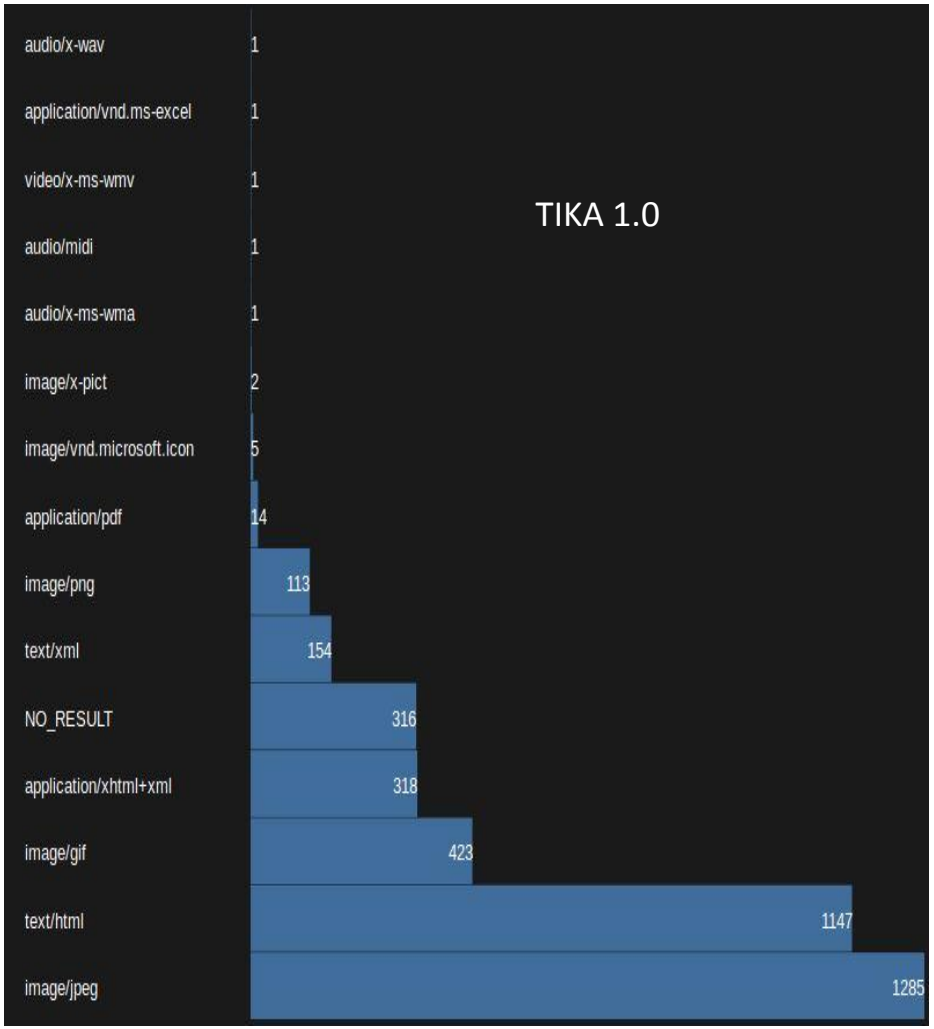


Tool integration pattern	Throughput (GB/min)
TIKA detector API call in Map phase	6,17 GB/min
FILE called as command line tool from map/reduce	1,70 GB/min
TIKA JAR command line tool called from map/reduce	0,01 GB/min

Amount of data	Number of ARC files	Throughput (GB/min)
1 GB	10 x 100 MB	1,57 GB/min
2 GB	20 x 100 MB	2,5 GB/min
10 GB	100 x 100 MB	3,06 GB/min
20 GB	200 x 100 MB	3,40 GB/min
100 GB	1000 x 100 MB	3,71 GB/min

Scenario 1: Web Archive Mime Type Identification





Key Data Austrian Books Online

Public private partnership with Google

Only public domain

Objective to scan ~ 600.000 Volumes

~ 200 Mio. pages

~ 70 project team members

20+ in core team

~ 130K physical volumes scanned so far

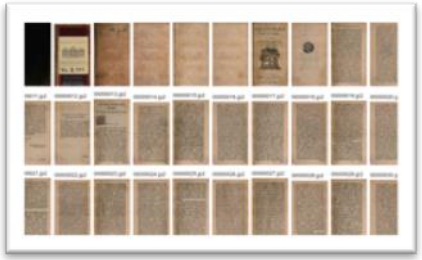
~ 40 Mio pages

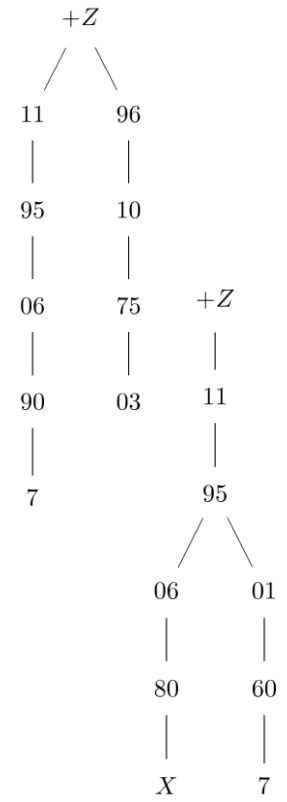
SCAPE

ADOCO (Austrian Books Online Download & Control)

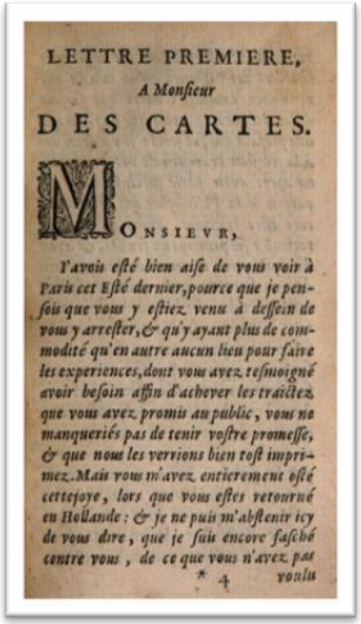
Digitisation → Download & Storage → Quality Control → Access

Google
Public Private Partnership





ADOCO


LETTRE PREMIERE,
A Monsieur
DES CARTES.
MONSIEVR,
I'avois eſté bien aiſe de vous voir à Paris cet Eſté dernier, pource que je penſois que vous y eſtiez venu à deſſein de vous y arreſter, & qu'y ayant plus de commodité qu'en autre aucun lieu pour faire les experiences, dont vous avez teſmoigné avoir beſoin afin d'achever les traittez que vous avez promis au public, vous ne manqueriés pas de tenir voſtre promeſſe, & que nous les verrions bien toſt imprimez. Mais vous m'avez entierement oſté cette joye, lors que vous eſtes retourné en Hollande: & je ne puis m'abſtenir icy de vous dire, que je ſuis encore faſché contre vous, de ce que vous n'avez pas voulu

https://confluence.ucop.edu/display/Curation/PairTree

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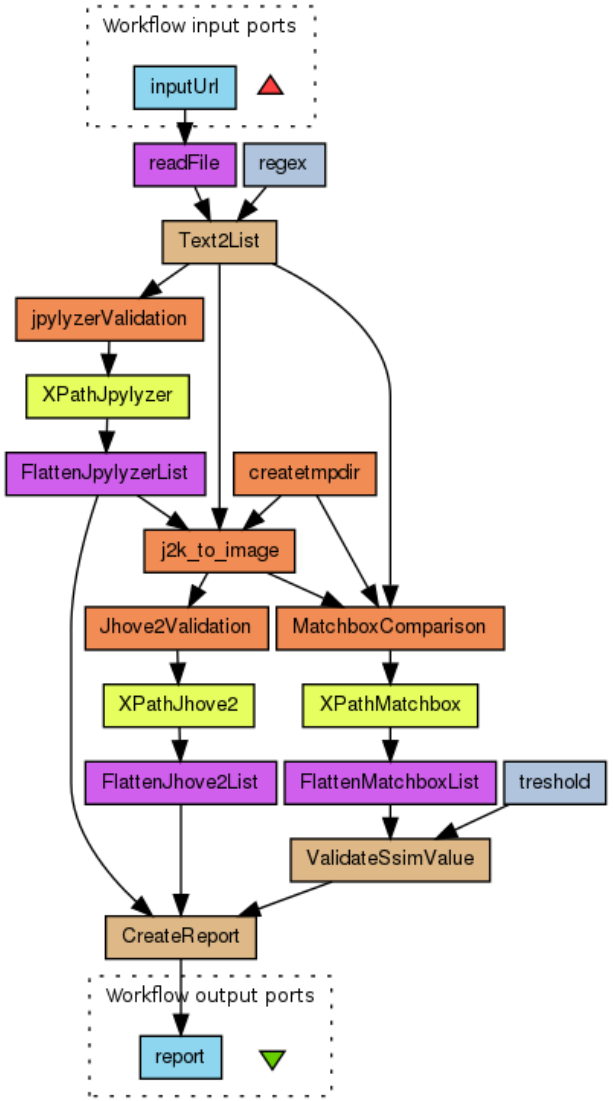
Scenario 2: Image file format migration

- Task: Image file format migration
  - TIFF to JPEG2000 migration
    - Objective: Reduce storage costs by reducing the size of the images
  - JPEG2000 to TIFF migration
    - Objective: Mitigation of the JPEG2000 file format obsolescense risk
- Challenges:
  - Integrating validation, migration, and quality assurance
  - Computing intensive quality assurance



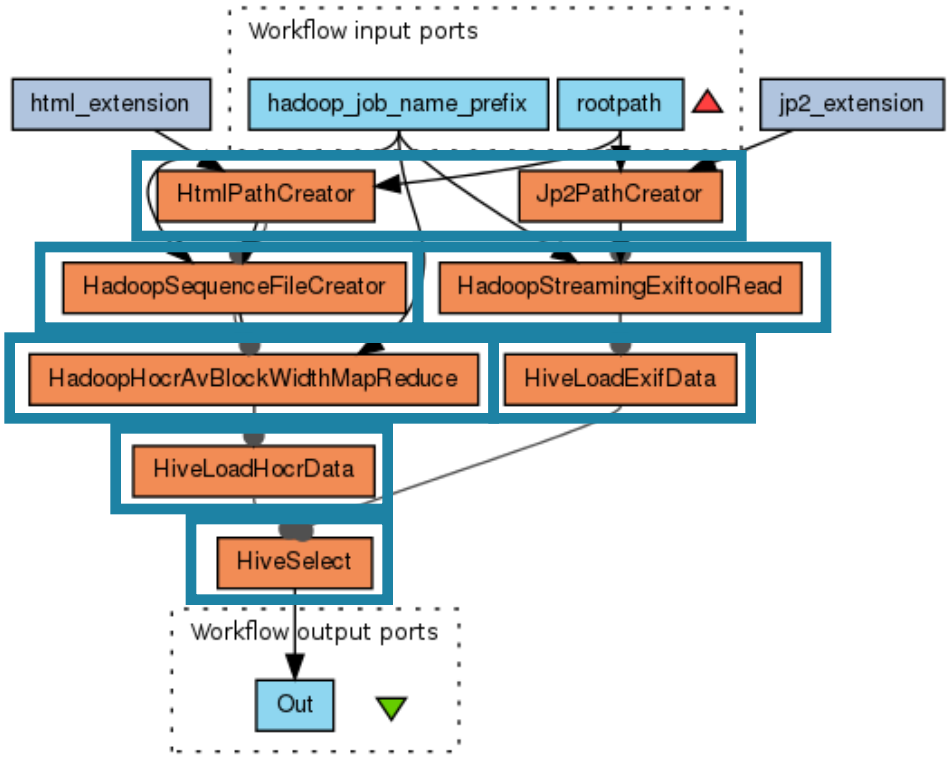
Scenario 2: Comparison of book derivatives

- Task: Compare different versions of the same book
  - Images have been manipulated (cropped, rotated) and stored in different locations
  - Images come from different scanning sources or were subject to different modification procedures
- Challenges:
  - Computing intensive (Average runtime per book on a single quad-core server ~ 4,5 hours)
  - 130.000 books, ~320 pages each
- SCAPE tool: Matchbox

Scenario 3: MapReduce in Quality Assurance

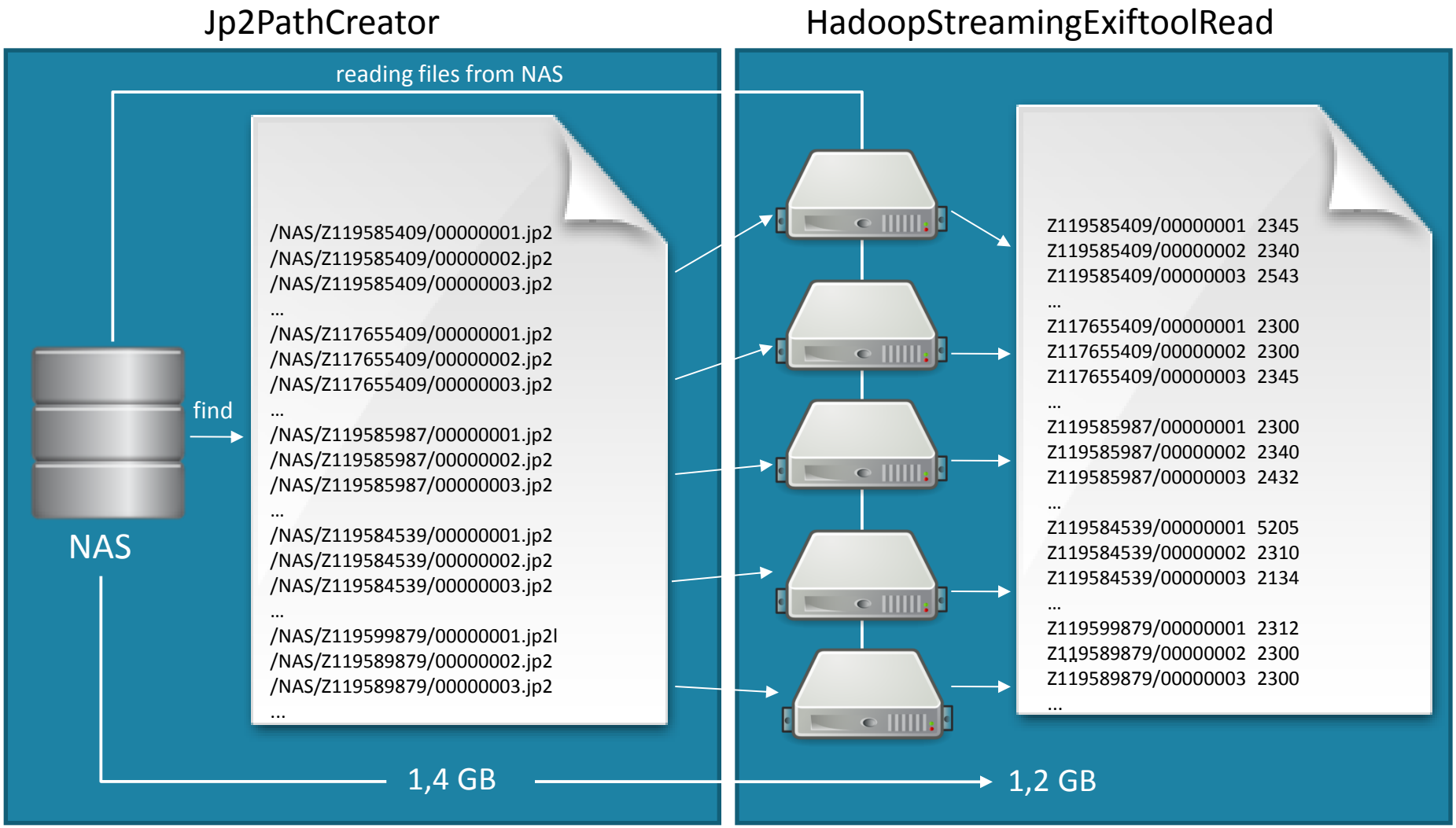
- ETL Processing of 60.000 books, ~ 24 Million pages
- Using Taverna‘s „Tool service“ (remote ssh execution)
- Orchestration of different types of hadoop jobs
  - Hadoop-Streaming-API
  - Hadoop Map/Reduce
  - Hive
- Workflow available on myExperiment:
  http://www.myexperiment.org/workflows/3105
- See Blogpost:
  http://www.openplanetsfoundation.org/blogs/2012-08-07-big-data-processing-chaining-hadoop-jobs-using-taverna

Scenario 3: MapReduce in Quality Assurance



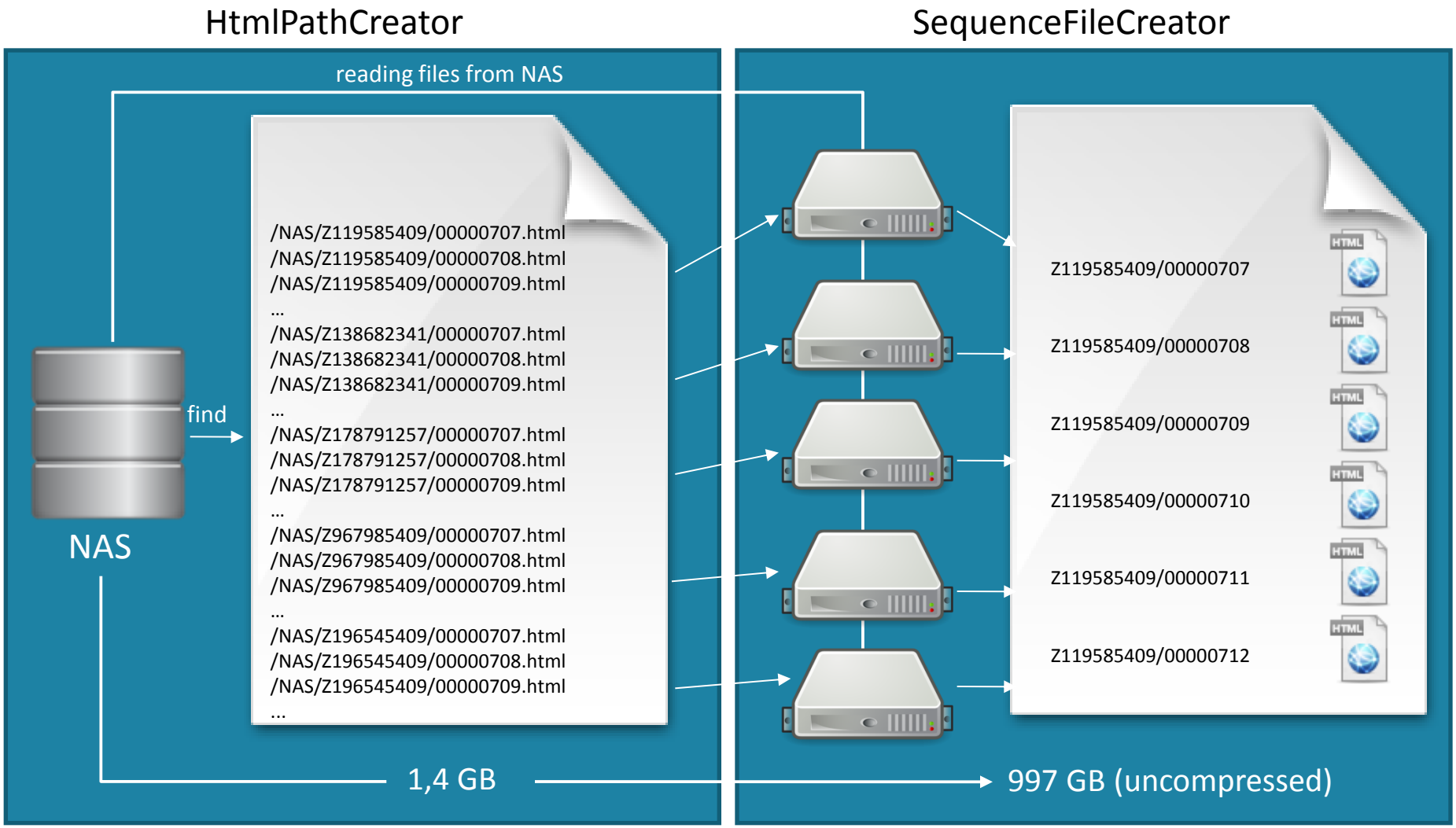
- Create input text files containing file paths (JP2 & HTML)
- Read image metadata using Exiftool (Hadoop Streaming API)
- Create sequence file containing all HTML files
- Calculate average block width using MapReduce
- Load data in Hive tables
- Execute SQL test query

Reading image metadata



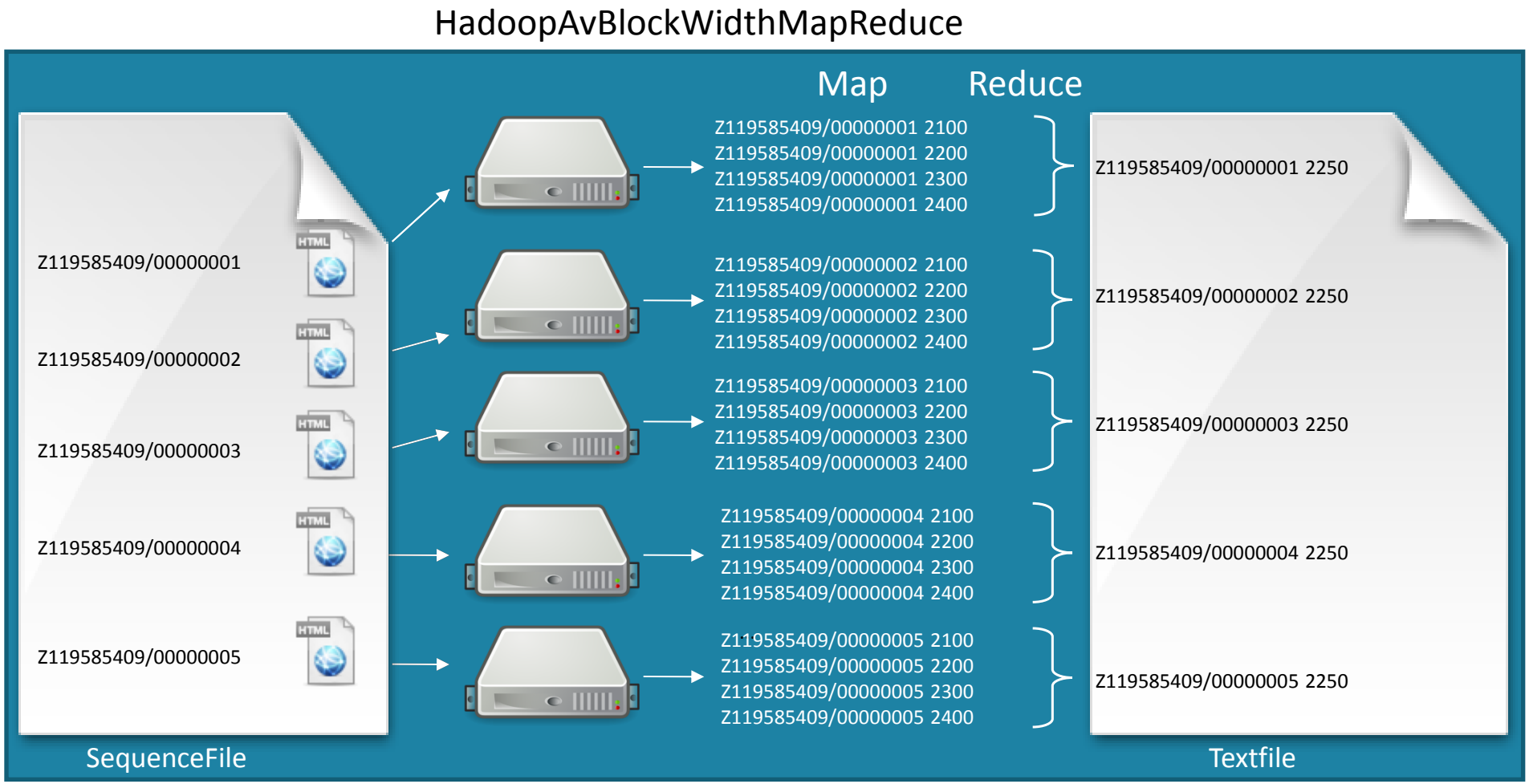
60.000 books (24 Million pages): ~ 5 h + ~ 38 h = **~ 43 h**

SequenceFile creation



60.000 books (24 Million pages): ~ 5 h + ~ 24 h = **~ 29 h**

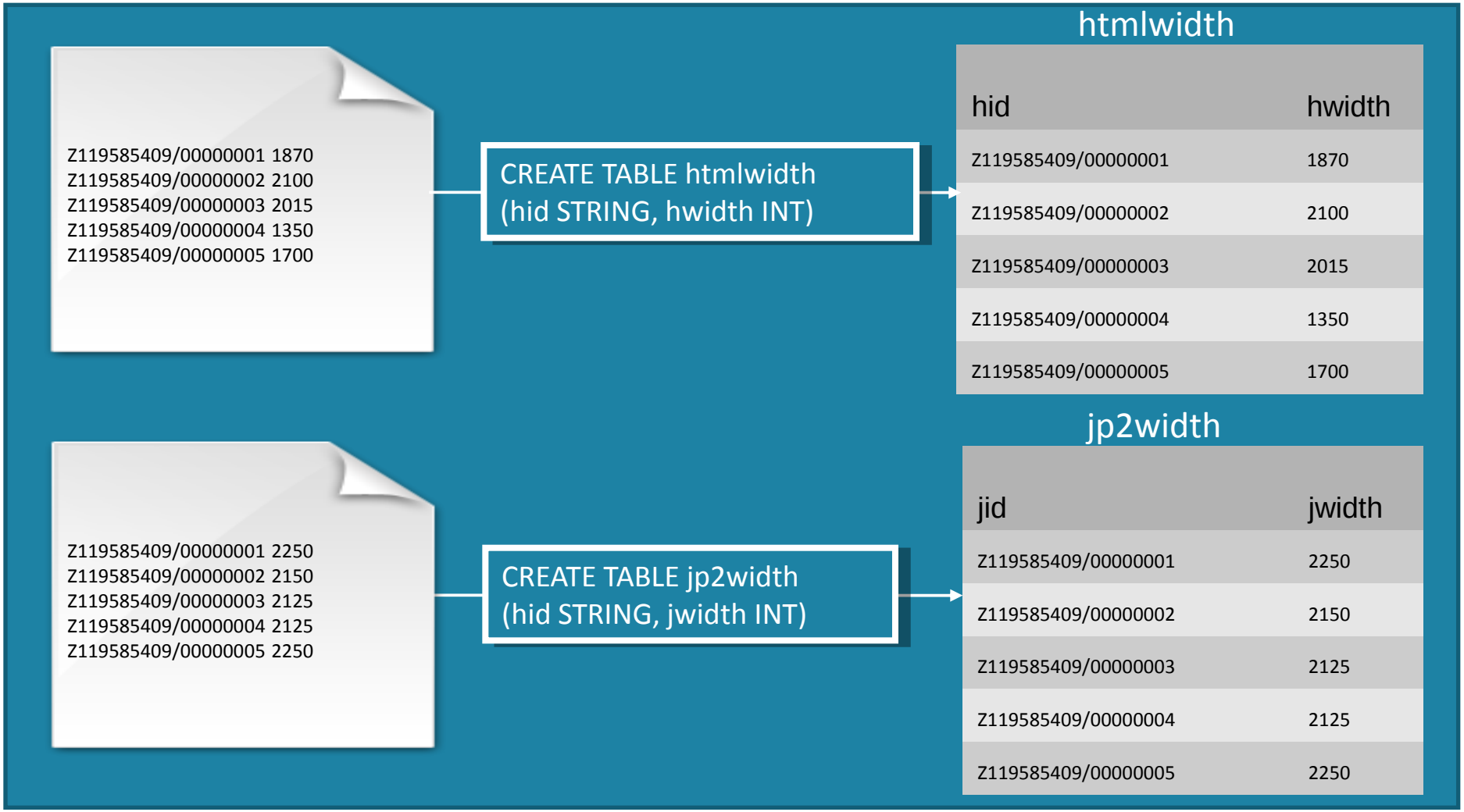
Calculate average block width using MapReduce



60.000 books (24 Million pages): **~ 6 h**

Analytic Queries

HiveLoadExifData & HiveLoadHocrData



Analytic Queries

HiveSelect

jp2width

jid	jwidth
Z119585409/00000001	2250
Z119585409/00000002	2150
Z119585409/00000003	2125
Z119585409/00000004	2125
Z119585409/00000005	2250

htmlwidth

hid	hwidth
Z119585409/00000001	1870
Z119585409/00000002	2100
Z119585409/00000003	2015
Z119585409/00000004	1350
Z119585409/00000005	1700

```
select jid, jwidth, hwidth from jp2width inner join htmlwidth on jid = hid
```

jid	jwidth	hwidth
Z119585409/00000001	2250	1870
Z119585409/00000002	2150	2100
Z119585409/00000003	2125	2015
Z119585409/00000004	2125	1350
Z119585409/00000005	2250	1700

Thank you! Questions?

Further information

- Project website: www.scape-project.eu
- Github repository: www.github.com/openplanets
- Project Wiki: www.wiki.opf-labs.org/display/SP/Home

SCAPE tools mentioned

- SCAPE Platform
  - http://www.scape-project.eu/publication/an-architectural-overview-of-the-scape-preservation-platform
- Jpylyzer – Jpeg2000 validation
  - http://www.openplanetsfoundation.org/software/jpylyzer
- Matchbox – Image comparison
  - https://github.com/openplanets/scape/tree/master/pc-qa-matchbox